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NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

PIPELINE ACCIDENT REPORT

NATIONAL FUEL GAS COMPANY
NATURAL GAS EXPLOSION AND FIRE
SHARPSVILLE, PENNSYLVANIA
FEBRUARY 23, 1985

NTSB/PAR-85/02

ORIGINAL

UNITED STATES GOVERNMENT

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16. Abstract At 2:40 a.m., on February 23, 1985, a police patrolman on routine patrol smelled strong natural gas odors as he crossed railroad tracks while heading south on North Sixth Street in Sharpsville, Pennsylvania. He radioed this information to the Sharpsville Police Department dispatcher at 2:42 a.m.; the dispatcher relayed the information to the gas company by telephone at 2:43 a.m., and a gas serviceman was ordered to the scene. At 3:15 a.m., before the serviceman arrived at the site of the reported leak, a tavern and a connecting building exploded and burned, killing two persons. Firefighters arriving on scene moments later encountered a second, smaller explosion which injured one firefighter. Gas company personnel shut off the gas to the leak site at 4:15 a.m. The National Transportation Safety Board determines that the probable cause of the accident was the gas company's failure to understand the limitations of the restraining-type coupling in holding plastic pipe during thermal contraction, which led to the pullout of a 6-inch-diameter, polyethylene plastic gas main from its coupling. The pullout allowed natural gas under 50-psig pressure to escape, to migrate through the soil, to accumulate in two nearby buildings, and to ignite from an undetermined source. Contributing to the accident was the gas company dispatcher's slowness, due to lack of training and guidelines, in perceiving the severity of the gas leak and in requesting the local police, already on site, to evacuate and to ventilate nearby buildings.			
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**NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D. C. 20594**

PIPELINE ACCIDENT REPORT

Adopted: October 25, 1985

**NATIONAL FUEL GAS COMPANY
NATURAL GAS EXPLOSION AND FIRE
SHARPSVILLE, PENNSYLVANIA
FEBRUARY 23, 1985**

SYNOPSIS

At 2:40 a.m., on February 23, 1985, a police patrolman on routine patrol smelled strong natural gas odors as he crossed railroad tracks while heading south on North Sixth Street in Sharpsville, Pennsylvania. He radioed this information to the Sharpsville Police Department dispatcher at 2:42 a.m.; the dispatcher relayed the information to the gas company by telephone at 2:43 a.m., and a gas serviceman was ordered to the scene. At 3:15 a.m., before the serviceman arrived at the site of the reported leak, a tavern and a connecting building exploded and burned, killing two persons. Firefighters arriving onscene moments later encountered a second, smaller explosion which injured one firefighter. Gas company personnel shut off the gas to the leak site at 4:15 a.m.

The National Transportation Safety Board determines that the probable cause of the accident was the gas company's failure to understand the limitations of the restraining-type coupling in holding plastic pipe during thermal contraction, which led to the pullout of a 6-inch-diameter, polyethylene plastic gas main from its coupling. The pullout allowed natural gas under 50-psig pressure to escape, to migrate through the soil, to accumulate in two nearby buildings, and to ignite from an undetermined source. Contributing to the accident was the gas company dispatcher's slowness, due to lack of training and guidelines, in perceiving the severity of the gas leak and in requesting the local police, already on site, to evacuate and to ventilate nearby buildings.

INVESTIGATION

The Accident

At 2:40 a.m., on February 23, 1985, a Sharpsville, Pennsylvania Police Department patrolman (patrolman) on routine patrol in his cruiser with the windows open even though it was raining, smelled a strong natural gas odor as he crossed railroad tracks while heading south on North Sixth Street between Shenango and Main Streets in Sharpsville. (See figure 1.) At 2:42 a.m., he radioed the police dispatcher and advised him to report the gas odor to the National Fuel Gas Company (gas company). At 2:43 a.m., the police dispatcher telephoned the gas company's dispatcher office in Erie, Pennsylvania, and reported, "We have a bad gas leak---somewhere---trying to pinpoint it. We can't pinpoint it down. It's covering pretty near a two-block area. It is strong." At 2:49 a.m., a gas company serviceman (serviceman) was contacted at his home in Hermitage, Pennsylvania, and ordered to the leak site.

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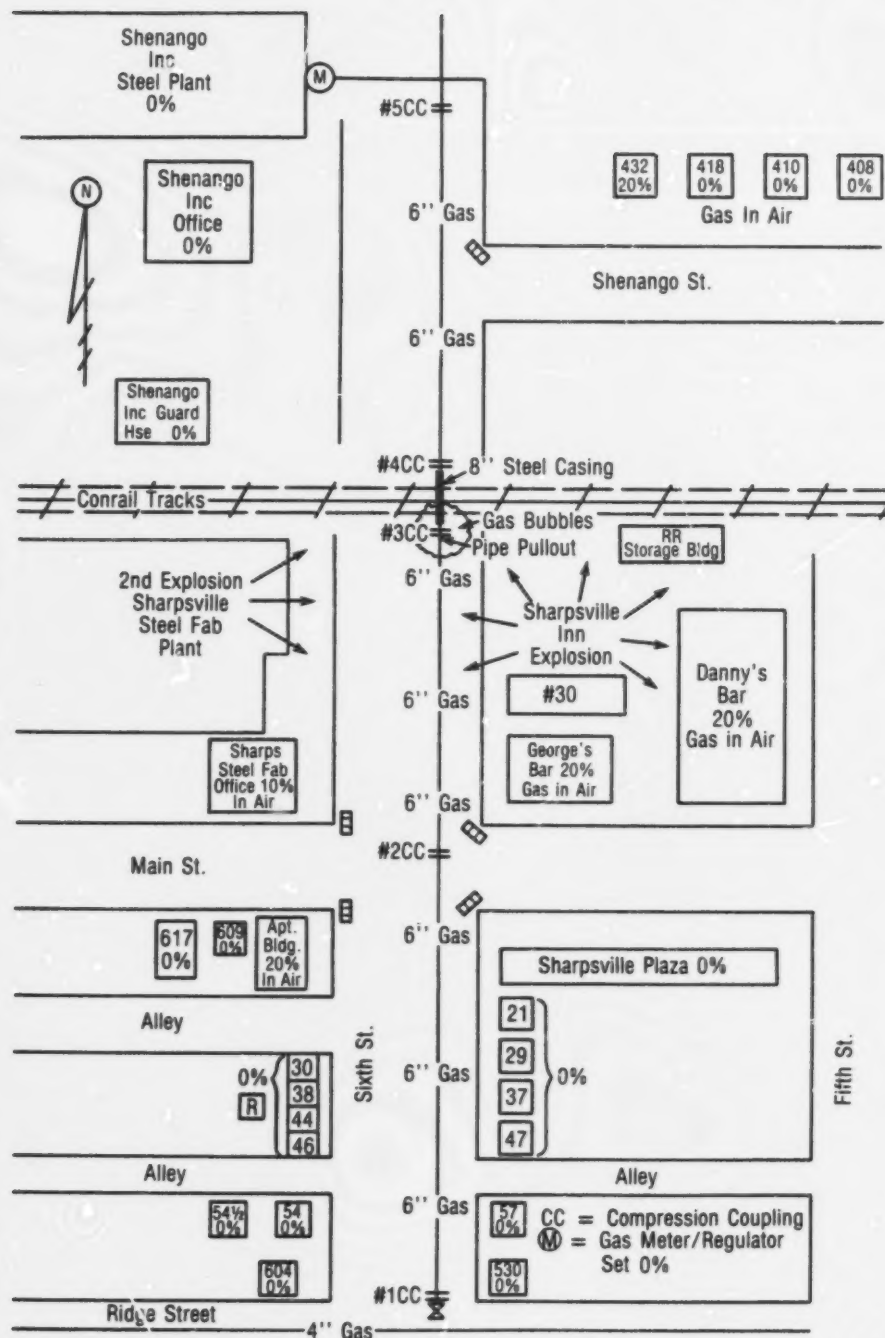


Figure 1.—Plan view of accident site.

At 2:50 a.m., the owner of Danny's Bar, located near the intersection of North Sixth and Main Streets, telephoned the police dispatcher and complained of a strong gas odor inside the bar. The police dispatcher radioed this information to the patrolman who had made the earlier report. The patrolman drove to the bar, walked through the bar, and although he did not smell a gas odor, ordered everyone to leave. The patrolman then returned to where he had smelled the gas odor earlier, got out of his cruiser, and saw gas blowing up through puddles of rainwater in North Sixth Street at the railroad crossing. At 2:55 a.m., the patrolman radioed the police dispatcher, gave him the leak location, and told him that it was a bad leak, possibly a broken gas main; this information was telephoned to the gas company. The patrolman then parked his cruiser at the northwest corner of the Sharpsville Inn at 34 North Sixth Street (see figure 1), close to the railroad crossing, and walked around the leak site. A breeze blowing from the southwest was carrying the gas odor away from the buildings and along the open railroad right-of-way. The rain increased about this time and forced the patrolman back into his parked cruiser. The patrolman did not evacuate anyone from the Sharpsville Inn because earlier, at 2 a.m., he had looked into the Sharpsville Inn which was closed, could not see anyone inside, and assumed the inn was empty.

At 3 a.m., the gas company received a telephone call from a woman at 13 Fifth Street stating, "There is a terrible gas smell in this house, what should I do?" The gas company dispatcher took her name and address and told her that a serviceman would be there shortly. He then asked whether the gas was coming from the inside or outside of the house and whether she had shut off the gas yet. She replied that she was not sure of how to shut off the gas and asked the gas company dispatcher, "Should we get out of here?" The gas company dispatcher replied, "Yes, if you feel it's too strong to stay in there." The caller replied that she had a lot of animals in the house and did not think she could sit in a car or in her neighbor's house. The gas company dispatcher then said, "Well if you feel it is too strong to stay there, I would suggest you go outside, but that is entirely up to you—if you feel it is too strong or not safe. We will have a serviceman stop by and check it out for you." The serviceman, who had left his house in Hermitage about 3:03 a.m. to drive to the gas company's Sharon, Pennsylvania, office to pick up his service truck, was contacted by the gas company dispatcher at 3:22 a.m. by radio and told to check out the gas odor complaint at 13 Fifth Street.

At 3:15 a.m., the Sharpsville Inn exploded and then burned. The police cruiser, which was parked at the northwest corner of the inn, was blown 35 feet across the first set of railroad tracks where it landed upright but damaged. The patrolman in the cruiser was slightly injured and badly shaken. He radioed the police dispatcher about the explosion and requested firefighters. He then drove the cruiser to the intersection of North Sixth and Main Streets where he established a traffic control unit to restrict sightseers and to keep the area open for the firetrucks. (See figure 1.)

The first firefighter arrived at 3:19 a.m. As he unreeled a hose from the firetruck, an explosion occurred in a steel company building across the street from the Sharpsville Inn. (See figure 1.) The blast knocked down the firefighter and blew out some windows and steel panels in the steel company building, but no fire resulted. (See figure 2.) One other firefighter was injured later in fighting the fire. The firechief arrived and immediately called in a pumper and a rescue unit from Sharpsville as well as one pumper each from the Hermitage and South Pymatuning Fire Departments. The combined units fought fires in the Sharpsville Inn, the two-story apartment at 30 North Sixth Street (adjacent to the inn), and in the Sharpsville Distributors building at 506 West Main Street. The fires were declared under control by 5:30 a.m. on February 23, 1985. After the fires were extinguished, two bodies were found in the rubble of the Sharpsville Inn.



Figure 2.—Sharpsville Inn (top) after explosion and fire,
and steel company building (bottom) after explosion.

At 3:25 a.m., 42 minutes after the gas company had been notified of the gas odors, the serviceman arrived on site, saw the exploded building and the fires, and radioed the information to the gas company dispatcher at 3:27 a.m., the first notification the gas company dispatcher had of the explosion. He requested a gas company emergency crew with maps of the area to respond as fast as possible. The gas company dispatcher ordered additional gas company personnel to respond. Firefighters asked the serviceman to shut off the flow of gas to the accident site, but the serviceman did not know where the gas main valves were located and could not shut off the flow of gas. He did not have any maps of the area and had to await the arrival of the emergency crew.

Company maps showed that there was a 6-inch-diameter, high-pressure, polyethylene plastic gas main under North Sixth Street at the railroad track crossing and also that there was a 3-inch-diameter, low-pressure, steel gas main on the east side of the larger main. About 3:45 a.m., the gas company district manager radioed the serviceman that the gate valves necessary to shut off gas to the area were located at the intersection of Ridge and Sixth Streets and asked the serviceman to meet him at that location. The valve box covers were located, cleared of snow, and opened. Both valves looked alike and were located side by side in the valve boxes. At 4 a.m., one valve was closed and the crew at the leak site watched to see if the gas stopped bubbling and blowing on the south side of the railroad tracks. After a few minutes the gas was still blowing with the same intensity at the leak site, so at 4:15 a.m. the other valve was closed; the gas stopped blowing almost immediately.

Gas company personnel evacuated the tenants, shut off the gas meters, and ventilated the 12-unit apartment building on the southwest corner of North Sixth and Main Streets. The building on the northwest corner of North Sixth and Main Streets also was evacuated and ventilated, and the gas meters were shut off. The gas meter for the house south of the Sharpsville Inn also was shut off. The gas service line to the Sharpsville Inn was shut off. A house that was found to be full of gas odors at the northeast corner of North Sixth and Shenango Streets was evacuated and ventilated, and its gas meter was shut off. Gas was detected in the storm and sanitary sewers, and exhaust fans were used to speed the dissipation of the trapped gas. Approximately four square blocks of Sharpsville were affected by the leaking, migrating gas. A gas company emergency crew drilled 1-inch-diameter holes through the road pavement at intervals along North Sixth and Main Streets to allow the gas trapped beneath the pavement to ventilate. About 11:45 a.m., after the area was checked and found to be free of gas, relighting was begun for those residences connected to the steel gas main, but the plastic gas main was kept shut off.

After the relighting process was begun, a gas company crew began to excavate in North Sixth Street south of the railroad tracks where the blowing gas had been observed. The plastic gas main was uncovered. A coupling used to join the lengths of plastic pipe was located 37 inches south of the open end of an 8-inch-diameter steel casing pipe in which the 6-inch-diameter plastic gas main was installed under the railroad tracks. The plastic pipe had pulled 3/4 inch out of the north end of the coupling. (See figures 1 and 3.)

At the direction of the Safety Board, and monitored by the Pennsylvania Public Utility Commission, the plastic pipe was carefully measured, photographed, and examined in place in the excavation before a section of the pipe was removed, replaced, and gas service restored to the industrial customer the gas main served. No indication of dried or caked earth was noticed around the pipe.



Figure 3.—Six-inch-diameter plastic pipe shown pulled out 3/4 inch from its coupling.

Injuries to Persons

	<u>Gas company</u>	<u>Civil agencies</u>	<u>Area residents</u>	<u>Total</u>
Fatal	0	0	2	2
Nonfatal	0	3	0	3
Total	0	3	2	5

Damage

The Sharpsville Inn, an adjoining ceramic shop with an upstairs apartment, and a two-story apartment building on the south side of the inn were destroyed by the explosion and fire. Other buildings to the north, east, and south of the inn sustained glass breakage throughout a 150-foot radius of the leak. Debris from the explosion was found up to 300 feet east of the inn. The steel company building across North Sixth Street from the inn sustained glass breakage and steel panel damage from the explosion at the inn and from the later explosion within the building. The cruiser was damaged. Total property damage was extensive.

The gas company estimated that the damage to its facilities was \$20,000 to \$25,000; however, this did not include the relighting or the precautionary removal and replacement of three couplings on the plastic gas main.

Pipeline System

The National Fuel Gas Company is the holding company of the National Fuel Gas Supply Corporation, the National Fuel Gas Distribution Corporation, the Seneca Resources Corporation, the Penn-York Energy Corporation, and Empire Exploration, Inc. These companies are engaged in all phases of the natural gas business--exploration, production, purchasing, gathering, transmission, storage, and distribution. The National Fuel Gas Distribution Corporation sells gas to consumers in western New York State, in northern Pennsylvania, and in a small area of northeastern Ohio. The company owns and operates about 2,200 miles of gas transmission pipelines and about 13,000 miles of gas distribution pipelines and serves 672,000 residential, commercial, and industrial customers.

The gas main that failed was a 1,500-foot-long, 6-inch-diameter, polyethylene plastic gas main installed in July, August, and September of 1979. The gas main from its connection with a 4-inch-diameter steel gas main on Ridge Street extended northward under North Sixth Street and under the railroad tracks and terminated at a meter-regulator station at the steel company building. (See figure 1.) The gas company construction crew that installed the gas main had joined the 40-foot-long lengths of plastic pipe by the heat-fusion process, except that at five locations where, because of interference with other underground utilities where space was limited, they used Dresser 700 "posi-hold" compression couplings with plain roller grip gaskets manufactured by Dresser Industries, Inc. (Dresser). The gas main was tested pneumatically to 98-psig pressure for 2 1/2 hours and then placed in service to the steel company building, the only customer it served. The 3-inch-diameter, coated-and-wrapped steel gas main, which had been installed before the plastic main, lay on the east side of the plastic main, was a low-pressure line (4 inches water column), and served area residences; it did not serve any industrial customers.

The gas company engineering department received and reviewed the drawings for the plastic main to the steel company building, which had been prepared by the gas company's operating division. The engineering department reviewed the pipe size, the pipe specifications, the pressure rating, the regulator, and the meter size. The engineering department did not calculate any forces due to contraction that might be experienced on this line, nor did the department check any of the couplings for pullout ratings. The fact that approximately 120 feet of the 6-inch-diameter plastic pipe was to be installed in an 8-inch-diameter steel casing pipe and would be unrestrained also was not considered.

A pressure-recording gage is located on the plastic gas main in a vault at the intersection of North Sixth and Main Streets. The 7-day recording chart is replaced each Sunday, and the replaced chart is analyzed for pressure changes indicative of gas usage by downstream customers. The recordings are not transmitted to any point in the system for purposes of observation or alarm. A postaccident examination of the chart revealed that a sudden sharp pressure drop from 49 psig to 25 psig occurred at 3:45 a.m. on February 23. (See figure 4.) The chart had been placed on the clock drive at 10:30 a.m. on February 17, 1985, and the first ink mark shown on the chart was made at 11 a.m. on February 17, 1985.

The gas company sub foreman who was in charge of installing the plastic gas main in 1979 had been shown how to install the various types of Dresser 700 "posi-hold" couplings, and he stated that he personally had installed dozens of them. His instruction was on-the-job training whereby he was shown by his supervisor how to install the coupling and then was required by his supervisor to install one by himself to show his supervisor that he could do it correctly. The sub foreman stated that he was not aware that there were any markings on the couplings to differentiate their intended use, i.e., to make steel-to-steel, plastic-to-plastic, or plastic-to-steel connections. He further stated that he had never been informed that there were any differences in the couplings or that specific couplings were to be used on specific types of pipe.

Personnel Information

Gas Company.—The gas company dispatcher on duty during the accident had been employed for 7 years, the last 2 years as a dispatcher. He received on-the-job training, which involved working and observing the work of a more senior dispatcher during each of the three work shifts. He worked the 8 a.m.-to-4 p.m. shift for 1 week, the 4 p.m.-to-12 midnight shift for 1 week, and the 12 midnight-to-8 a.m. shift for 1 week. The trainee learned how incoming gas odor complaints and leak complaints were to be handled, how to call out gas company servicemen to handle the complaints, and what to do in emergencies. On the first shift (8 a.m.-to-4 p.m.) a trainee is both instructed and observed by the supervisor of the dispatching department. On each of the other two shifts a trainee is instructed and observed by the senior dispatcher working that shift. At the end of the 3-week training period, the department supervisor talks to each of the senior dispatchers with whom a trainee had worked to get their evaluation of the trainee's capabilities. If the trainee is deemed capable, he becomes a dispatcher and works a different shift each week. If the trainee is not deemed capable of handling the duties of a dispatcher by himself, the trainee is given more on-the-job training until such time as the department supervisor determines that the trainee can handle the job alone. No formal curriculum or classroom training is involved, and no written final test is given. Later, the trainee is questioned from time to time by supervisors as to what he would do under certain circumstances.

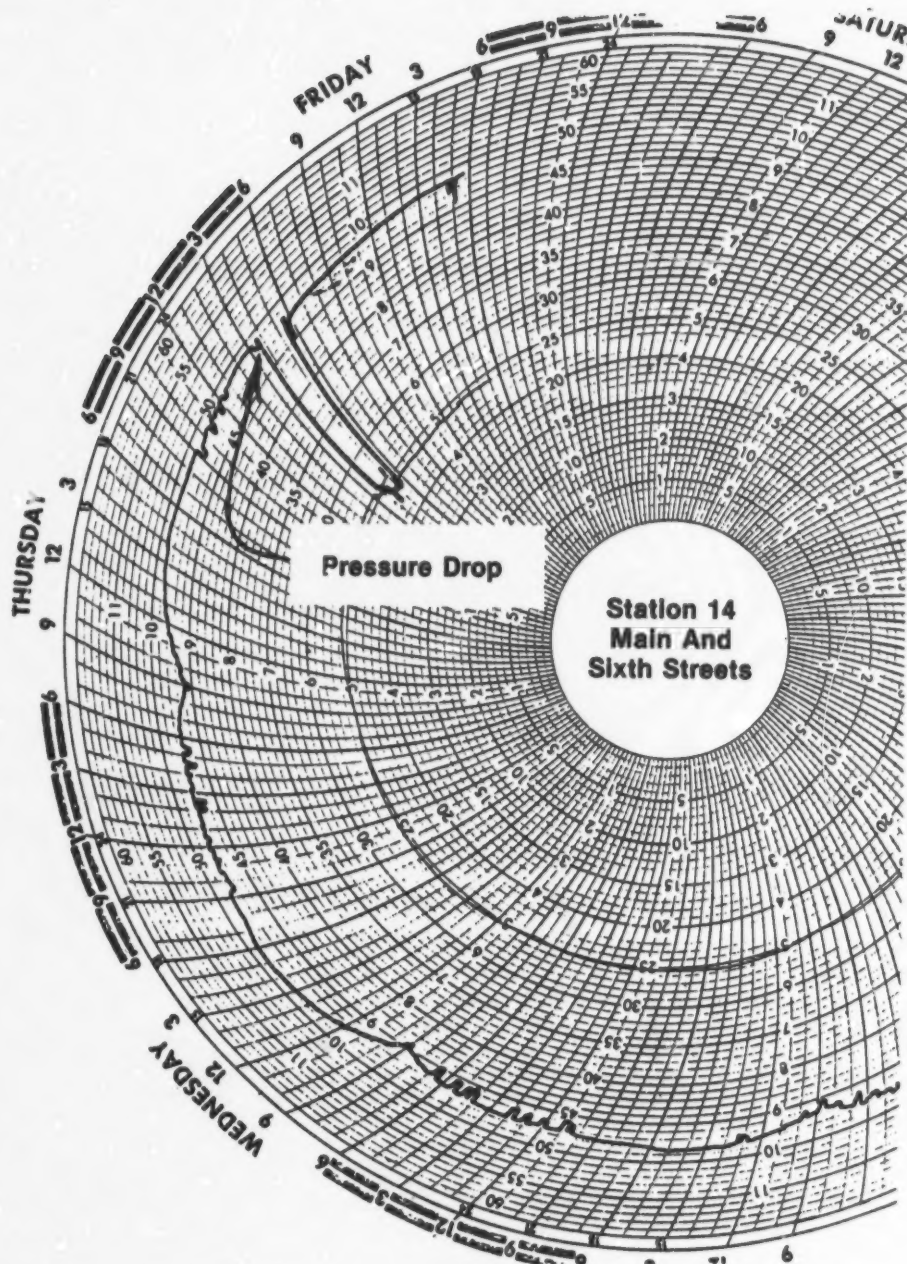


Figure 4.—Pressure recording chart from vault
at North Sixth and Main Streets.

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Maps of the gas company facilities are located in the dispatcher office. The trainee learns to use these maps to locate a gas leak before calling out a serviceman. In addition, there is a checklist of things to do and questions to ask when a dispatcher receives a gas odor or gas leak complaint. (See figure 5.) The dispatcher on duty during this accident noted that no formal procedures were available to explain how to work with various police and fire departments during emergencies, but that his instructors during on-the-job training had informed him to use civil agencies when necessary to alert residents, to ventilate buildings, and to evacuate persons from buildings when the gas company serviceman would not be able to get to a leak site within a reasonable time.

The serviceman who was the first of the gas company personnel to be notified of the leak report and who was the first of the gas company personnel to arrive at the accident site, had been employed for 17 years, the last 6 years as a serviceman. The serviceman had attended courses in gas appliance hookups and maintenance and trouble-shooting, which contained some classroom work and textbooks. The rest of his training, like the dispatcher's, was on-the-job training wherein he received "hands-on" experience. The serviceman had never received formal training in the area of emergency response to gas accidents; however, he stressed the need to use common sense and good judgment at these times. He had not received specific training in using civil agencies to assist in evacuating persons, ventilating buildings, or turning off ignition sources in gas emergency areas.

Fire Department.—Sharpsville Fire Department personnel stated that at various times they had received both classroom and "hands-on" training given by Pennsylvania State and county fire agencies. This training included the use of new types of equipment, the handling of hazardous materials, instruction in first aid, etc. The training did not specifically include natural gas leaks and fires except for basic concepts such as allowing gas-fed fires to burn under controlled conditions until the gas source could be located and shut off. The firechief stated that in his 10 years' experience in the department neither he nor any of his firefighters had received any training from the gas company. He did recall one session given by the gas company at a county-sponsored fire training course, but he remembered it as a general discussion rather than specific training in gas leakage, gas ignition, gas permeation, loss of odorant, building ventilation, or personnel evacuation. The fire department at the time of the accident had a general emergency plan, which did not include gas emergencies; however, after the accident gas emergency procedures were added.

The gas company stated that it participated in a Mercer County, Pennsylvania Fireman's Association meeting in 1981 that four Sharpsville firefighters, including the firechief, attended. At that meeting the gas company presented a slide program together with instructional pamphlets concerning methods of handling gas emergencies. This program was available on request by any of the fire departments. The Sharpsville Fire Department did not request the program.

Meteorological Information

Just before the explosion the patrolman had reported a hard rain falling that forced him to take cover in the cruiser. He also reported a breeze from the southwest.

The National Weather Service (NWS) at Youngstown, Ohio (the nearest weather station to Sharpsville) showed the weather through the early morning hours of February 23, 1985, to be overcast with light rain beginning at 1:20 a.m. and continuing until 5:40 a.m., totaling 0.08 inch. The temperature was 46° F, and the wind was 12 knots from 230 degrees.

**NATIONAL FUEL GAS
DISTRIBUTION CORPORATION**

**Telephone Procedure
For Odor Of Gas Calls**

1. Customer's name, address, township in which they reside and telephone number.
2. How strong is the gas odor?
 - (a) Very strong in general area.
 - (b) Strong in specific location.
 - (c) Faint odor.
3. Where is the odor?
 - (a) Inside - be specific - Kitchen, Basement, Appliance, etc.
 - (b) Outside - location - How close to building?
4. How long had the odor persisted?
 - (a) Minutes. (b) Hours. (c) Days.
5. Possible cause of leak?

Suggestions to Customer

**BE CALM - Do Not Communicate
Panic To The Customer.**

**Very Strong - Open the house and if
felt necessary, evacuate
the house. Be very
selective with this
advice.**

**General Odor Throughout The House -
Shut off at meter, if
possible.**

**Odor at Appliance, Just Developed -
Ventilate, if strong.**

**If inside piping is broken, suggest
they stop the leak with something,
such as a rag, potato, soap.**

**BE CALM - Do Not Communicate
Panic To The Customer.**

Figure 5.—Dispatcher checklist for telephone complaints of gas leaks.

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For the three winter months of December 1984, January and February 1985, the NWS recorded the high, low, and median temperatures for each month as follows:

	<u>Average high temperature (°F)</u>	<u>Average low temperature (°F)</u>	<u>Median temperature (°F)</u>
December 1984	44	28.3	36.2
January 1985	25.4	12.9	19.2
February 1985	32.5	15.7	24.1

December 1984 was 6.8° F warmer than normal, January 1985 was 5.0° F colder than normal, and February 1985 was 1.8° F colder than normal.

For the three summer months of July, August, and September 1979, when the gas main was constructed, the NWS recorded the following high, low, and median temperatures for each month:

	<u>Average high temperature (°F)</u>	<u>Average low temperature (°F)</u>	<u>Median temperature (°F)</u>
July 1979	78.7	58.1	68.4
August 1979	77.7	58.5	66.0
September 1979	73.1	50.9	62.0

Medical and Pathological Information

Two persons, the owners of the Sharpsville Inn, were killed when the inn exploded and collapsed while they were inside. A firefighter injured his back when he was knocked down by the second explosion. Another firefighter injured his back and ribs when he fell while operating a valve on a firetruck. The patrolman injured his right hip when his cruiser was propelled 35 feet by the first explosion.

Tests and Research

The Safety Board tested and analyzed at its metallurgical laboratory in Washington, D.C., the Dresser 700 "posi-hold" coupling and about 18 inches of the attached plastic pipe from the south side of the railroad tracks where the pullout occurred. (See figure 6.)

The failed coupling was photographed, measured, and cut apart revealing the following:

- o The couplings had the correct roller-grip gasket prescribed for use with plastic pipe; it was the correct coupling for joining plastic to plastic.
- o The plastic pipe had been fully inserted into the coupling at the time of installation;
- o The coupling appeared to have been pressured to 5,500 psig as required to expand the cavity between the inner and outer steel shell to force the roller-grip gasket tightly against the circumferential wall of the plastic pipe to make a tight seal;

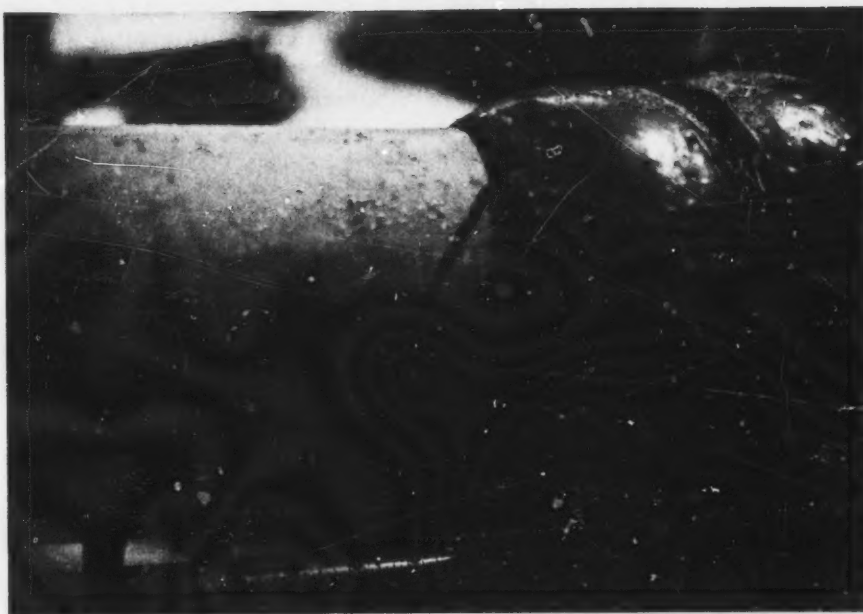
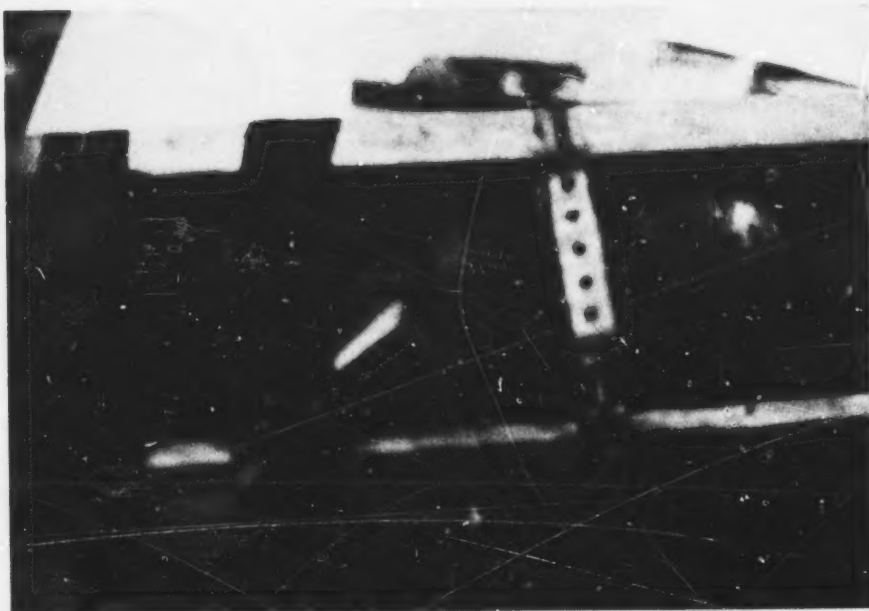


Figure 6.—Dresser 700 "posi-hold" compression coupling with plain roller grip gaskets as shipped to laboratory (above) for analysis of the pullout (below).

- o The plastic pipe was in correct alignment with the coupling; and
- o The plastic pipe had contracted a total of 3.750 inches from its initial insertion in the coupling. The contraction took place in six stages, as indicated by six distinct marks left by the coupling on the plastic pipe.

The Safety Board also examined a second Dresser 700 "posi-hold" coupling installed at a location on the north side of the railroad tracks 129 feet from the first coupling. The examination revealed that the correct coupling (plastic-to-plastic) had been installed, that it had been installed correctly, and that it had not pulled out.

The other three Dresser 700 "posi-hold" couplings remaining in the pipeline were removed for testing at the direction of the Safety Board. The couplings were located at North Sixth and Ridge Streets, North Sixth and Main Streets, and at a point 289 feet north of the railroad tracks where the plastic gas main turned into the steel company building. (See figure 1.) The three couplings were X-rayed to see if any pullout had occurred and to what extent. The couplings from North Sixth and Ridge Streets and from North Sixth and Main Streets showed no evidence of pullout; the coupling from where the gas main turned into the steel company building showed about 3/4 inch of pullout.

The couplings that had been removed from the pipeline at North Sixth and Ridge Streets and at the steel company building were sent to the National Bureau of Standards (NBS) for testing and analysis. Each coupling had been cut out of the pipeline with about 12 inches of the original pipe on each end. The NBS chilled the coupling from North Sixth and Ridge Streets to approximately 35° F, the approximate ground temperature at the time of the failure, and began to pull it apart at a strain rate of 0.2 inch per minute, the strain rate that Federal regulations (49 CFR 192.283(b)(3)) require a mechanical joint to withstand. After 4 minutes at a load of 2,846 kilograms (KG) (6,274 pounds), 1/ the pipe moved out of the coupling approximately 1/4 inch. The initial movement came at approximately 2,673 KG (5,893 pounds). After the initial movement the strain application was stopped for 5 minutes. The strain was reapplied until the coupling moved again, and the strain was again removed for 5 minutes. This test was repeated until the plastic pipe pulled out completely from the coupling as follows:

<u>Dresser coupling pipe loadings</u>	<u>Pipe movement in coupling</u>
1st pull peak load = 2,846 KG (6,274 pounds)	
2nd pull peak load = 2,673 KG (5,893 pounds)	6 MM (0.236 inch)
3rd pull peak load = 2,682 KG (5,913 pounds)	8 MM (0.315 inch)
4th pull peak load = 2,149 KG (4,738 pounds)	14 MM (0.551 inch)
5th pull peak load = 1,156 KG (2,549 pounds)	15 MM (0.591 inch)
6th pull peak load = 138 KG (304 pounds)	27 MM (1.057 inches)
pullout	70 MM (2.750 inches)

The coupling gaskets were examined and found to be plain roller-grip gaskets--the correct type of gasket for plastic installation.

The NBS tested the coupling from the steel company building line at the same strain rate of 0.2 inch per minute, but at room temperature (approximately 72° F). During this test, the load was not relaxed at first pipe movement, and the pipe was pulled out

1/ One kilogram is approximately equal to 2.2046 pounds.

of the coupling completely. At 1,976 KG (4,356 pounds) the pipe began to pull out of the coupling. After pullout the coupling gaskets were examined and were found to be the ARMOREX conductive gasket--the type to be used for steel-to-steel connection, not for plastic-to-plastic construction; the gas company had used the wrong coupling at this location during construction in 1979.

The coupling from North Sixth and Main Streets was examined at the Safety Board laboratory and found to have the correct gasket (plain roller-grip) required for plastic-to-plastic connection.

All of the couplings in all of the tests were found to have been installed with the correct amounts of pipe insertion, pipe alignment, and installation pressure.

Other Information

Dresser Couplings.—The Dresser 700 "posi-hold" coupling involved in this accident was manufactured in 1975 through 1978 in 2-, 3-, 4-, and 6-inch diameters and employed a plain roller-grip gasket in each end. The 6-inch-diameter, 7-inch-long coupling involved in this accident was intended for joining steel piping or plastic piping interchangeably when installed in accordance with the manufacturer's installation instructions and product ratings. The Dresser 700 "posi-hold" couplings were sold only to the Columbia Gas Company (Columbia Gas) and the National Fuel Gas Company. A total of 4,389 2-inch-diameter couplings, 5,553 3-inch-diameter couplings, 6,629 4-inch-diameter couplings, and 821 6-inch-diameter couplings were sold to these two companies. The couplings were not designed to restrain plastic pipe until the pipe failed; the coupling involved in this accident was rated to restrain plastic pipe up to 2,700 pounds of tensile force (pull).

Other Dresser couplings that were in use at the time were designed for three distinct and not interchangeable applications: (1) to join steel pipe to steel pipe, (2) to join plastic pipe to plastic pipe, and (3) to join plastic pipe to steel pipe. The couplings looked the same physically and were installed in the same manner, but the gaskets inside the couplings that would encircle the inserted pipe and provide the gas-tight seal were different. The resistance to pipe pullout also was different for each of the three types of pipe to be joined (steel-to-steel, plastic-to-plastic, and steel-to-plastic). All couplings were marked or branded to denote which type of pipe they were intended to join and, in the case of plastic-to-steel joints, which end of the coupling was to hold the plastic pipe. (See figure 7.)

Dresser advertised that its plastic-to-plastic and plastic-to-steel transition couplings (not the type involved in this incident) would restrain pullout forces to the point where the plastic pipe would fail before a pullout from this coupling could occur. The Dresser Sales Catalog pictorially shows the Dresser 700 "posi-hold" transition couplings steel-to-plastic pipe and makes the following statement:

Now you can make the transition from steel pipe to polyethylene pipe, (or polyethylene pipe to polyethylene pipe), safely and economically. The new Dresser 700 "posi-hold" TRANSITION Couplings provide a line of specially designed products for joining 1 1/4" IPS, 2" IPS and 6" IPS pipe. These products meet all the requirements of D.O.T. Regulation # 192, since the joint will restrain pullout until the pipe fails outside the coupling or fitting. Special gaskets "lock" the coupling and the pipe together, preventing pull-out. [emphasis added]

DRESSER 6 PL 700 ROLLER GRIP GSKT

Identification Of Coupling Used At Sharpville

DRESSER 6 IPS 700 PLASTIC PIPE END

Predecessor Couplings Showing Plastic Or
Steel End Connection

DRESSER 6 IPS 700 STEEL PIPE END

Predecessor Couplings Showing Plastic Or
Steel End Connection

Figure 7.—Dresser coupling identification.

The new TRANSITION couplings utilize the time and field proved advantages and gas-tight sealing of regular Dresser "700" POSI-HOLD couplings. The same installation equipment may be used as for the regular POSI-HOLD couplings and fittings. No welders or special fusion equipment are required. Your own crew or your contractor's crew can make the joints in less than five minutes, above or in the ditch.

Check these advantages of the new Dresser TRANSITION couplings:

1. Proved principle for joining pipe - Five years field experience with regular POSI-HOLD couplings and fittings.
2. Safe, positive holding strength - Meets D.O.T. Regulation # 192 in all respects.
3. Easily installed in any weather - no welders required. Existing "700" field tools can be used for installation.
4. Economical - Fast assembly.
5. No exact pipe fitting.
6. Gas-tight permanent joints.
7. Working pressure same as the polyethylene pipe.
8. Install from top--no need for large bell-holes.
9. Low profile--easy to coat or wrap.
10. Steel insert supplied with each coupling.

Why not start realizing all the benefits of this safe, efficient method every time you connect polyethylene pipe to existing steel pipe, or polyethylene pipe to polyethylene pipe?

However, the transition couplings could not be used interchangeably on steel or plastic pipe; care had to be taken by the installer to be sure that the correct coupling was used for the steel or plastic pipe connection. Because of this constraint, Columbia Gas, which had purchased hundreds of the transition couplings, became concerned that the couplings could get mixed up when removed from the warehouse for installation so that a steel-to-steel coupling might inadvertently be installed on a plastic-to-plastic joint. Moreover, on an installation requiring a steel-to-plastic connection, the company was concerned that the coupling end intended to hold the plastic pipe might be switched inadvertently to receive the steel pipe. Any errors thus made would invalidate the coupling guarantee of a positive hold against pullout or leakage. As a result Columbia Gas requested Dresser to test and provide the results of the roller-grip gasket then in use on steel-to-steel pipe connections when used to connect polyethylene pipe of the diameters, types, and wall thicknesses used in its systems even though it was aware that the holding strength would be considerably less than the values required to yield or elongate the plastic pipe. Columbia Gas intended to use the values to design its systems to conform to Federal requirements detailed in 49 CFR 192.273(a).

The resulting coupling, the Dresser 700 "posi-hold" coupling with plain roller-grip gaskets and with ratings as noted above, was offered by Dresser and accepted by Columbia Gas as a coupling that could be used interchangeably on either steel or polyethylene pipe within the ratings recommended. The 2,700-pound rating for the 6-inch-diameter size is the ultimate rated load, and a suitable safety factor has to be applied in a proper system design. Loading the coupling beyond this value could cause the pipe to pull out completely. No reference is made in Dresser's literature to a recommended safety factor, thus leaving the safety factor to the gas company's pipeline design department. The Dresser 700 "posi-hold" coupling with plain roller-grip gaskets was not promoted or offered by Dresser to the gas industry in general and was not listed in the Dresser Sales Catalog. National Fuel became aware of it through contacts with Columbia Gas, and National Fuel ordered a total of 1,578 couplings, of which 236 were the 6-inch-diameter size. National Fuel does not have any more of the couplings in stock, and it estimated that perhaps 50 to 100 of the 6-inch-diameter size couplings were installed throughout its system; it cannot account for the difference between the 236 couplings ordered and the 50 to 100 couplings installed.

In 1979 Dresser began to manufacture the "700"-series coupling in 9-inch lengths to allow greater room for error in cut-in applications, and the 7-inch-long series coupling was discontinued. In September 1982 Dresser introduced the 700 "posi-hold" universal coupling, employing a totally new concept, which could be used on steel pipe, plastic pipe, or a combination of both and meet the requirements of 49 CFR 192.283(b). The current Dresser Sales Catalog showing the types of fittings manufactured does not include the "posi-hold" coupling involved in this accident; however, the 2,700-pound limitation is shown in Dresser's installation manual for the coupling. The coupling with plain roller-grip gaskets sold to Columbia Gas and ultimately to National Fuel was not intended to be sold to the gas industry in general and was, therefore, not included in the Dresser Sales Catalog.

Dresser felt that because of its pullout limitation (2,700 pounds for the 6-inch-diameter coupling), the coupling should not be sold to the gas industry and that its transition coupling already being marketed with two gaskets and a gripper ring was a better coupling regarding its restraint capability. In a letter to Columbia Gas dated January 20, 1975, Dresser stated:

We would like to emphasize the fact that the pipe pullout resistance values shown are "ultimate" and any safety factor you desire for your piping must be calculated on that basis.

The National Fuel assistant superintendent said that at the time the plastic gas main was installed in 1979, gas company personnel considered the "posi-hold" coupling involved in this accident to be a restraining-type coupling, in which the pipe would fail before the coupling let go. However, he also acknowledged that the gas company had been provided pullout data because the data were included with the installation procedures.

Plastic Pipe.—The pipe involved in this accident was 6-inch-diameter, Dupont Aldyl "A" polyethylene 2306 SDR11.5 plastic pipe. The pipe is manufactured in 40-foot lengths and has a coefficient of expansion/contraction of 1.08 inch per 10° F change per 100 feet of pipe.

The coefficient of expansion/contraction of plastic pipe is about seven times that of steel pipe, i.e., with the same temperature drop, a 700-foot length of plastic pipe will contract approximately 7 inches for a 10° F temperature decrease while steel pipe will contract approximately 1 inch. This information is printed in the Dupont Aldyl "A" Product and Installation Manual. The manual details eight different procedures for installing plastic pipe, but does not describe any procedures for joining plastic pipe with couplings. Salespersons for the Aldyl "A" pipe do not discuss the specific effects of forces of contraction that plastic pipes exert on couplings; however, these salespersons do alert gas company personnel to the thermal contraction properties of plastic pipe. If more information about plastic pipe uses is needed by the gas company purchasing the plastic pipe, the salespersons advise them to contact the Aldyl "A" technical services group.

The following table was developed to show the amount of contraction of 129 feet of plastic pipe in the casing for each 10° F temperature change:

(Based on a coefficient of expansion of 1.08 inch/10° F/100 feet)

<u>Temperature (° F)</u>	<u>Inches contraction</u>
-10	1.08 x 1.29 x 01 = 1.3932
-20	1.08 x 1.29 x 02 = 2.7864
-30	1.08 x 1.29 x 03 = 4.1796
-40	1.08 x 1.29 x 04 = 5.5728
-50	1.08 x 1.29 x 05 = 6.9660
-100	1.08 x 1.29 x 10 = 13.9320

The estimated force exerted by 6-inch-diameter, Dupont Aldyl "A" polyethylene 2306 SDR11.5 plastic pipe as a result of a 10° temperature change is 1,550 pounds ^{2/} based on an instantaneous change. In the gradual yearly cycle of temperature changes, which allows stress relaxation, 43 percent of the instantaneous value more accurately reflects "as installed" conditions, such as soil restraint.

<u>Temperature (° F)</u>	<u>Pounds contraction force on coupling</u>
10	= 1,550
20	= 3,100
30	= 4,650
40	= 6,200
50	= 7,750
100	= 15,500

Federal Regulations For Mechanical Joints.—Title 49 CFR 192.283(b)(5) Plastic Pipe; qualifying joining procedures, specifies as to mechanical joints the stresses which are to be applied, as follows:

Pipe specimens 102 mm (4 in) and larger in diameter shall be pulled until the pipe is subjected to a tensile stress equal to or greater than the maximum thermal stress that would be produced by a temperature

^{2/} E.I. Dupont de Nemours, Pull-Out Force On Joints In Polyethylene Pipe Systems, April 30, 1976.

change of 55° C (100° F) or until the pipe is pulled from the fitting. If the pipe pulls from the fitting, the lowest value of the five test results or the manufacturers' rating, whichever is lower must be used in the design calculations for stress.

The 6-inch-diameter, Dresser 700 "posi-hold" coupling with plain roller-grip gaskets would not hold plastic pipe that was subjected to a thermal stress produced by a temperature change of 55° C (100° F). It was assigned a manufacturer's rating of 2,700 pounds, which was recorded in Dresser's Installation Instruction Sheets, but not in its sales catalog.

ANALYSIS

The Accident

The 6-inch-diameter plastic gas main, although correctly installed in the Dresser coupling, pulled out of the coupling because the force produced by the contraction of the plastic pipe exceeded the maximum restraining ability of the coupling. The pullout did not occur all at once. It occurred at six different times in about equal amounts over the six winters following its installation in 1979. The contraction probably was caused by the temperature decrease from the time the pipe was installed in the summer of 1979 to the first winter of operation 1979/1980. The temperature difference caused the plastic gas main to contract and pull about 0.625 inch out of the coupling and then stop when the restraining forces of the soil around the gas main and the restraining force of the coupling equaled the forces generated by the contraction of the plastic gas main. Initially, the contraction force of the plastic gas main had been enough to overcome both the soil friction and coupling restraint and thus begin the pullout. But as the pipe began to pull out, its contraction forces were relieved until they became equal to the two opposing forces (soil and coupling), and when equilibrium occurred, the movement of the pipe in the coupling stopped. During the spring and summer of 1980, the soil around the pipe warmed up, further relieving the forces from the pipe contraction, and the pipe expanded an amount approximating its contraction during the winter of 1979/1980, creating a force pushing it back into the coupling. However, while the pipe did expand (elongate) during the summer, 120 feet of it was in steel casing and unrestrained by any soil friction, so the pipe curved ("snaked") in the casing rather than reentering the coupling. This winter/summer contraction/expansion process repeated itself six times from 1979 until 1985 as evidenced by the six marks left by the coupling on the plastic pipe surface. Finally, the pipe pulled out completely in February 1985, and gas under 50-psig pressure escaped.

Two factors contributed to this pullout: one, National Fuel did not fully comprehend the limitations of the special coupling and did not calculate and compensate for the contraction in the plastic pipe; and two, Dresser, which did not want to sell these special couplings to anyone other than Columbia Gas and therefore did not advertise them in its sales catalog or explain their capabilities and limitations through sales visits to other gas companies, unwittingly allowed 1,578 of these couplings to be sold to National Fuel. As a result of these two factors, four of the special couplings with plain roller-grip gaskets (and one coupling that should have been used only on steel pipe) were installed in the 1,500-foot-long, 6-inch-diameter plastic gas main with a pullout limitation of 2,700 pounds. The temperature difference required (in an unrestrained area in the casing) to produce a tensile force of 2,700 pounds was about 17.6° F. This temperature is well within the temperature range in western Pennsylvania as determined from the State of Pennsylvania, Bureau of Materials Report of Frost Action on Pavements. As a result pullout did occur, and gas under 50-psig pressure escaped, migrated, exploded, and burned.

Dresser Coupling

The coupling with plain roller-grip gaskets involved in this accident was not designed to hold plastic pipe under any and all conditions. It had a rating of 2,700 pounds at which point any plastic pipe could be expected to begin to pull out. Dresser salespersons did not have occasion to point out the fact that the coupling had limitations, because they did not solicit the sale of the couplings to any company other than Columbia Gas. National Fuel bought these couplings directly as a result of talking with Columbia Gas, because it also saw the advantage of using one type of coupling to eliminate the possibility of an error in selecting the correct coupling to join different types of pipe. Dresser's advertisement that its "joint will restrain pullout until the pipe fails outside the coupling" applied only to one style of coupling and not to the 700 "posi-hold" coupling with plain roller-grip gaskets involved in this accident. National Fuel should have been concerned about the stresses caused by contraction in the plastic pipe and should have made the appropriate calculations. The gas company could have requested information about the limitations of the coupling from Dresser's Technical Services Department; it did not avail itself of this service. In turn, had Dresser's sales organization been made aware of the sale of the coupling to National Fuel, it is likely, given Dresser's practices, that Dresser would have contacted the gas company to describe the coupling's capabilities and limitations.

Gas Company Engineering

The 6-inch-diameter, Dupont Aldyl "A" polyethylene 2306 SDR11.5 plastic pipe involved in this accident has a coefficient of expansion/contraction about seven times that of steel pipe, i.e., for each 1 inch that a steel pipe contracts, this plastic pipe would contract 7 inches under the same conditions. Moreover, for every 10° F temperature drop this plastic pipe would contract 1.08 inch per 100-foot length, or 16.2 inches over the entire 1,500-foot length of this pipeline, if unrestrained by soil or other forces. The gas company engineering department never calculated the contraction forces which would be caused by predictable temperature drops in the area where the plastic pipe was to be installed. Moreover, it did not calculate the forces or potential forces that would be exerted on the coupling; it assumed that the coupling would hold the pipe against all forces, and as a result, the gas company installed 1,500 feet of 6-inch-diameter plastic pipe with five couplings that it assumed would hold so long as the forces did not exceed the rating of the pipe. However, the contraction forces of the plastic pipe exceeded the restraining force of the coupling, and a pullout resulted.

In an era when the use of plastic pipe is expanding rapidly in the gas distribution industry, it is imperative that gas companies become completely familiar with the forces that act upon pipe and the limitations of using couplings with the pipe. Company engineers must consider these factors carefully in their design calculations. Also, coupling and plastic pipe suppliers should make available to gas companies the full range of information on their products' limitations, as well as their products' virtues, so that there will be no question of what the products can and cannot do. The availability of information about product capabilities and product limitations becomes even more important as product changes and innovations are made by the supplier. The new information must be made available promptly to the ultimate user, and the user must install the product only after careful consideration of its capability.

In this case the new coupling's limitation (the fact that it might pull out before pipe failure) should have been evaluated fully by the gas company; the gas company also should have calculated the forces of contraction on the plastic pipe to determine if the pipe would need anchoring to prevent pullout. The calculation was not made; the gas company apparently concluded--based on Dresser's statement related to another line of couplings--that this coupling would hold until the pipe failed.

The Safety Board investigated seven gas distribution pipeline accidents between 1976 and 1985 in which plastic pipe pulled out of its coupling because either the coupling used was incorrect (nonrestraining) or the gas company did not know, or inquire how much plastic pipe could contract, or both. As a result of these accidents, the Safety Board urged gas industry and plastic pipe industry trade associations that could play an effective role in preventing a recurrence of similar accidents to disseminate information to their member companies about new products, to include both the products' limitations as well as their capabilities.

Fire Department and Gas Company Liaison

Thirty-five minutes elapsed between the time of the discovery of escaping gas at 2:40 a.m. until the explosion at 3:15 a.m. During that period the gas company promptly alerted and dispatched a serviceman to the site but, as in many similar accidents, the serviceman lived some distance from the leak site, had to get dressed and drive to the gas company offices to get a truck and equipment, and then had to drive to the accident site. In this accident the serviceman arrived at the accident site about 3:25 a.m., about 30 minutes after he was notified, but 10 minutes after the first explosion. This 30-minute response time was reasonable under the circumstances.

The gas company should have suspected the severity of the gas leak upon receiving the additional call about a strong gas odor from the resident at 13 Fifth Street after receiving the first report from the police dispatcher about a strong gas odor and a possible gas main break. The gas company dispatcher should have requested the assistance of the police and fire departments in ventilating and evacuating the buildings in the immediate area of the leak. The patrolman requested persons in one building to evacuate, but a request from the gas company for additional assistance might have initiated additional ventilation and evacuation efforts. A request for assistance by the gas company might have prompted the patrolman to enter the Sharpsville Inn to ventilate it, where he would have found the two people inside. Moreover, the gas company's instructions to its dispatchers, which led to the resident at 13 Fifth Street not being told to vacate her building in the face of not only her report of a strong gas odor but also reports of a strong gas odor throughout the area by the police dispatcher, were inappropriate.

The serviceman who first arrived at the site had not been trained by the gas company regarding specific actions to be taken during gas leak emergencies. Although it was too late in this case to do anything about the demolished buildings and the two fatalities, the serviceman did not begin immediately to alert or to evacuate people residing in the immediate area or to ventilate any of the area buildings. These actions were not taken until later when a gas company emergency crew arrived. Since gas companies must rely heavily on employees who are called out for emergencies, particularly at night, they should be given in-depth training in emergency procedures and in working and coordinating with local police and fire departments.

Since 1972 the Safety Board has investigated more than 19 gas distribution pipeline accidents, which involved 35 fatalities and 33 injuries and in which a request for assistance from the local emergency response agencies by the gas companies might have prevented many of the fatalities and injuries. Moreover, because the Board investigates only a small portion of the more than 1,200 gas distribution accidents reported annually (only those accidents involving a fatality or substantial property damage are investigated by the Board), the full effect of improved early notification by gas companies to local emergency response agencies cannot be assessed. The problem is not that gas companies are slow to respond, but that most gas companies have a limited initial response capability, particularly for nighttime incidents. Under normal conditions the gas company dispatcher, once informed of a leak or gas odor, must first verify it, make a determination of its severity, and call the serviceman; all of which takes time. In turn, the serviceman must drive to the problem area and begin his investigation, all of which takes still more time. From the point of view of public safety, it is important that the gas company dispatcher inform the local fire and police departments of the leak or gas odor reported and request that they make an immediate inspection of the affected area, determine the degree of hazard (and here the dispatcher can advise them), and make a decision to evacuate buildings, ventilate buildings, or monitor the area until the gas company serviceman arrives, thus saving much valuable time. When dealing with the possibility of deaths or injuries (not to mention property damage), it is far better to overreact on the side of public safety.

Pressure Recordings/Pressure Alarms

The patrolman first smelled the strong gas odor at 2:40 a.m., and the explosion occurred at 3:15 a.m. The pressure recording chart located at North Sixth and Main Streets that recorded the gas pressure on the plastic gas main showed a sudden, sharp pressure drop from 49 psig to 25 psig beginning at 3:45 a.m. The gas company had placed the chart on the clock drive at 10:30 a.m. on February 17, 1985, but the first ink mark on the chart was made at 11 a.m. on February 17, 1985; obviously, the pen had not been placed in the chart at the correct time. The 30-minute fast setting (11 a.m. vice 10:30 a.m.) does not explain the time difference on the chart, because such a difference would place the time of the pullout at the time of the explosion, 3:15 a.m. (3:45 minus 30 minutes).

When the valve on the failed plastic gas main was turned off at 4:15 a.m., the flow of gas into the failed section was stopped. That valve closure also restored pressure to the rest of the system almost immediately and would have led to a rapid pressure rise. Therefore, the rapid pressure rise depicted on the chart at 5:30 a.m. (see figure 4) actually occurred at 4:15 a.m. Thus, the chart time was fast by 1 hour 15 minutes. By subtracting 1 hour 15 minutes from the recorded time of the rapid pressure drop (first indicated about 3:40 a.m.), the time of the pullout can be established at 2:25 a.m., 15 minutes before the gas odor was detected by the patrolman and 50 minutes before the explosion at the Sharpville Inn.

If the recorded pressure chart information or a low pressure alarm had been transmitted to one of the gas company offices staffed 24 hours a day (preferably the dispatcher office), the alarm not only would have alerted the gas company to the leak but the sudden, rapid 25-psig pressure drop in a 50-psig pressure system also would have indicated a major leak. A proper assessment of this information would have given the gas company an additional 18 minutes (from the time of the pullout at 2:25 a.m. to the time

of the first telephonic notification at 2:43 a.m.) during which company personnel could have been notified and dispatched and the police and fire departments could have been requested to evacuate the area and ventilate the buildings. If this had been done, it is possible that the explosions would not have occurred or at least that the fatalities and injuries would not have resulted. The Safety Board advocates the transmission of gas pressure readings to continuously staffed gas company offices where trained personnel can monitor the information for rapid leak detection and can provide a timely response by gas company personnel.

In its report of an accident in Clinton, Missouri, on December 9, 1972, 4/ in which a natural gas explosion and fire killed eight persons and injured seven persons, the Safety Board noted that:

The gas company was not able to detect major problems in its system. The indication of the break appeared on the recording gauge 1 hour 20 minutes before the explosion. If this had been promptly detected [by a telemetered pressure recording] and considered along with the gas leak, the situation probably would have been handled differently and the accident might have been prevented.

As a result of its investigation, the Safety Board issued Safety Recommendation P-74-16 on February 27, 1974, to the Office of Pipeline Safety (now the Materials Transportation Bureau (MTB)) of the U.S. Department of Transportation (DOT):

Revise 49 CFR 192.741 to require pipeline operators to telemeter gas pressure or flow data in such a way as to insure prompt warnings of significant system failures shown by pressure or flow changes. The type and location of the data points should be considered on an individual basis and should include single-feed systems serving substantial numbers of customers.

The DOT issued an Advance Notice of Proposed Rulemaking (ANPRM) on June 28, 1974, and then withdrew the ANPRM on September 21, 1978, based on objections raised about the technical difficulties of requiring all pipeline operators to use telemetry. The Safety Board agreed with some of the technical objections, and because on July 31, 1978, the Board had issued Safety Recommendation P-78-43 to the American Society of Mechanical Engineers (ASME) and Safety Recommendation P-78-44 to the MTB (as a result of the Board's investigation of a pipeline accident in Cherokee, Alabama, on July 30, 1977.), which called for the use of telemetering on single-feed gas systems, the Safety Board determined that Safety Recommendation P-74-16 should be closed and that the issue of telemetering should be pursued through Safety Recommendations P-78-43 and -44. These recommendations currently are in an "Open—Acceptable Action" status and are being actively pursued by the Board. Recommendation P-74-16 was classified as "Closed—No Longer Applicable" on February 22, 1979.

Also as a result of the Clinton investigation, the Safety Board issued Safety Recommendation P-74-19 on February 27, 1974, to the Gas Piping Standards Committee of the ASME:

Develop guidelines for the use of telemetering on gas distribution systems so that system failures can be promptly detected.

4/ Pipeline Accident Report—"Missouri Public Service Company, Clinton, Missouri, December 9, 1972" (NTSB-PAR-74-3).

Safety Recommendation P-74-19 was classified as "Closed—Acceptable Action" on July 29, 1985, by the Safety Board based on the guide material presented in the 1983 edition of the ASME Guide.

Also as a result of the Clinton accident, the Safety Board issued Safety Recommendation P-74-22 on February 27, 1974, to the Missouri Public Service Company (MPS):

Install telemetering equipment at the Clinton and other town border stations, so that system failures can be promptly detected.

The MPS replied that it "is presently investigating, along with others in the (gas) industry, the feasibility of installing telemetering equipment at town borders. To date it has not yet been determined whether such action on the part of the company would contribute significantly to the safe operation of the system." Safety Recommendation P-74-22 is classified as "Open—Acceptable Action."

Since the Clinton accident in 1972, the Safety Board has investigated four accidents in which the Board believes that transmission of pressure information to a continuously staffed gas company office would have either prevented the accident or mitigated the results of the accident. 5/ Safety Recommendations P-78-5, P-78-43, P-78-44, P-81-22, and P-83-36 were issued to various parties as a result of these investigations. The replies to these recommendations were basically the same as the replies to the recommendations issued in the Clinton, Missouri, accident; the gas companies were studying the problem, and the DOT stated that increased surveillance and customer education programs would solve the problem.

The Safety Board continues to believe that transmitted pressure data on single-feed systems is a viable, effective approach to the early detection of large leaks and, further, that this early detection can give the gas company valuable lead time in responding to an accident site and in requesting assistance from police and fire departments.

CONCLUSIONS

Findings

1. The gas company did not know the pullout force limitations of the Dresser 700 "posi-hold" coupling with plain roller-grip gaskets that it used to join the plastic pipe.
2. The gas company did not calculate or estimate prior to installation the forces that might be exerted on the coupling from the contraction of the plastic pipe or from earth movement affecting the pipe.
3. The gas company construction crew that installed the plastic gas main was unaware of the differences in the various types of couplings used to connect steel and plastic gas mains; as a result it installed an incorrect coupling (steel-to-steel) on the plastic gas main.

5/ Investigations of accidents in Cherokee, Alabama, on July 30, 1977; in Mexico, Missouri, on January 8, 1981; and Pipeline Accident Reports—"Consolidated Gas Supply Corporation, Propane Rupture and Fire, Ruff Creek, Pennsylvania, July 20, 1977" (NTSB-PAR-78-1); and "El Paso Natural Gas Company Compressor Station Explosion and Fire, Bloomfield, New Mexico, May 26, 1983" (NTSB-PAR-83/04).

4. The contraction of the plastic gas main occurred over a period of six winters until pullout occurred; on six occasions during the winters the pipe pulled out of the coupling a little farther until it pulled out completely.
5. The pullout occurred near the steel casing pipe on the south side of the railroad track where approximately 120 feet of the plastic pipe in the casing lay unrestrained by soil forces and was free to contract and expand.
6. Three of the other four couplings in this gas main, which were of the same type as the failed coupling, did not fail because soil frictional forces on the plastic pipe aided in restraining the contraction of the pipe.
7. The natural gas escaped from the gas main, permeated the surrounding soil, entered the sewer system, and entered the Sharpsville Inn where it accumulated and was ignited by an undertermined source.
8. The Sharpsville Fire and Police Departments were not aware of the ability of natural gas to migrate underground for considerable distances.
9. The gas company serviceman who responded initially was not trained adequately or equipped to respond effectively to the emergency.
10. The gas company did not provide an effective emergency response to the leak.
11. The gas company should have requested the police and fire departments to evacuate and to ventilate residences in the accident area before the arrival of the gas company serviceman.
12. If the recorded gas pressure readings or a low pressure alarm had been transmitted to the gas company's dispatcher office, the dispatcher would have been alerted to the major leak immediately, and he might have dispatched a serviceman earlier and requested immediate aid from the fire and police departments.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was the gas company's failure to understand the limitations of the restraining-type coupling in holding plastic pipe during thermal contraction, which led to the pullout of a 6-inch-diameter, polyethylene plastic gas main from its coupling. The pullout allowed natural gas under 50-psig pressure to escape, to migrate through the soil, to accumulate in two nearby buildings, and to ignite from an undetermined source. Contributing to the accident was the gas company dispatcher's slowness, due to lack of training and guidelines, in perceiving the severity of the gas leak and in requesting the local police, already on site, to evacuate and to ventilate nearby buildings.

RECOMMENDATIONS

As a result of its investigation of this accident, the National Transportation Safety Board made the following recommendations:

--to the National Fuel Gas Company:

Immediately institute a program to train its dispatchers periodically in the use of civil agencies to alert residents, to ventilate buildings, and to evacuate buildings in leak areas pending the arrival of responding gas company personnel. (Class II, Priority Action) (P-85-23)

Train its dispatchers and issue guidelines emphasizing the importance of determining the severity of a gas leak at the earliest possible time. (Class II, Priority Action) (P-85-24)

Include in its training program for its emergency response personnel procedures for contacting, coordinating, and cooperating with local emergency response agencies in communities served by the gas company. (Class II, Priority Action) (P-85-25)

Install pressure transmission or alarm equipment at strategic pressure-recording points to alert dispatchers promptly to emergency conditions as evidenced by abnormal pressures. (Class II, Priority Action) (P-85-26)

Instruct its engineering department to calculate prior to installation all of the forces anticipated to act upon a gas main and to compare the forces with the design limitations of couplings and other fittings to be used in the installation to ensure that the limitations are not exceeded. (Class II, Priority Action) (P-85-27)

Conduct a systemwide survey to identify any other locations where the 6-inch-diameter 700 "posi-hold" couplings with plain roller-grip gaskets were installed on plastic pipe, inspect those locations for indications of pipe pullout, and replace the couplings or anchor the pipe as required. (Class II, Priority Action) (P-85-28)

--to the Dresser Manufacturing Division of Dresser Industries, Inc.:

Review its intercompany communication practices, and revise them where necessary to ensure that customers ordering a new or modified product will be advised of the product's limitations. (Class II, Priority Action) (P-85-29)

--to the American Gas Association and the American Public Gas Association:

Notify member companies of the details of the accident in Sharpsville, Pennsylvania, on February 23, 1985, and urge them, when using couplings to join plastic pipe, to establish that the forces anticipated to act upon the couplings and the plastic pipe are within the design limitations specified by the manufacturer. (Class II, Priority Action) (P-85-30)

--to the Research and Special Programs Administration of the U.S. Department of Transportation:

Issue an advisory bulletin to alert gas distribution pipeline operators who use plastic pipe and couplings to establish that the forces anticipated to act upon the installation are within the design limitations specified by the manufacturer. (Class II, Priority Action) (P-85-31)

--to the American Society of Mechanical Engineers' Gas Piping Standards Committee and the American Petroleum Institute:

Develop, in coordination with national associations of emergency response agencies, guidelines for operators of pipelines describing the circumstances under which local emergency response agencies should be called to respond to pipeline emergencies and to take initial lifesaving measures, and describing the type and extent of training that should be provided to local emergency response agencies as first responders to pipeline emergencies. (Class II, Priority Action) (P-85-32)

--to the International Association of Fire Chiefs, Inc., the International Association of Chiefs of Police, and the International Society of Fire Service Instructors:

Cooperate with the American Society of Mechanical Engineers' Gas Piping Standards Committee and the American Petroleum Institute in the development of guidelines for operators of pipelines describing the circumstances under which local emergency response agencies should be called to respond to pipeline emergencies and to take initial lifesaving measures, and describing the type and extent of training that should be provided to local emergency response agencies as first responders to pipeline emergencies. (Class II, Priority Action) (P-85-33)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

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October 25, 1985